

laid on the association of ideas as a starting point, not merely an *ex post facto* explanation, than modern psychologists would be prepared to grant to it. The savage examples of inheritance through females are far from being parallel to the rule of succession by marriage, assumed to be the Latin rule.

Of Dr. Frazer's charm of style and literary skill in arranging his material it is needless to speak, and the points noted above detract in no way from the interest of the book, which, indeed, might rest its reputation on the classical material alone. An adequate index is provided.

N. W. T.

#### A COMPENDIUM OF NATURAL KNOWLEDGE.

*Landolt-Börnstein—Physikalisch-chemische Tabellen.*  
Dritte Umgearbeitete und vermehrte Auflage. By  
Drs. Börnstein and Meyerhoffer. Pp. xvi+861.  
(Berlin: Julius Springer, 1905.) Price 36 marks.

THE promised new edition of Profs. Landolt and Börnstein's well-known tables of constants, a work which has long been familiar in the laboratories of physicists and chemists throughout the world, has at length appeared after being in the press nearly three years.

As regards the number of pages, the book contains about half as many again as the second edition published in 1894, and three times as many as the first edition of 1883.

A book such as the present volume may be compiled on several different plans. An attempt may be made to give a complete list of all determinations of any physical constant, with references in each case. This method, however, would entail enormous labour and make the resulting volume very ponderous without conferring any additional advantage on the user, except, perhaps, the specialist interested in the history rather than the present accepted value of any physical constant. A second plan would be to collect from the whole literature only the more recent references, and a third to give, as is usual in the various pocket-books, a single value for each constant. In the compilation of the present work no one of these systems has been followed throughout, although the rule of giving a reference to the source of information has been rigidly followed in each case. The result is undoubtedly the most complete work of reference of its kind in any language, if we except the treatise on physical constants now being brought out by the French Physical Society, which will require many volumes for its completion. The original compilers have called to their aid about forty specialists, and in all cases the name of the person responsible appears at the foot of each table.

To criticise a work of this kind is no easy task; indeed, to do it at all adequately the editor would be obliged to call in the services of a number of reviewers rather than a single individual. In the writer's opinion, however, the object of a reviewer should be rather to attempt to appreciate the book in question at its true value, and to indicate whether in his opinion it is likely to serve the purpose for which it is intended, rather than to put together a long list of

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grammatical slips and printer's errors, though this side of the question need not go wholly without attention.

A cursory comparison of the book with the earlier editions of 1883 and 1894 will convince everyone of the substantial advance that has been made both in our knowledge and in the completeness of the work in question. Indeed, this very completeness in certain directions appears at times almost appalling. For every person who wishes to look up the index of refraction for the green thallium line of "Camphocarbon-säurekohlensäurediethylester," which is given, there would probably be a hundred who would be glad to be informed as to the electrical properties of Acheson graphite, which is not mentioned, and a thousand who would like some more precise indication as to the melting point of common salt than simply a catalogue of values varying from 776° to 820° C.

Indeed, the character of the information excluded from the book at once proclaims the preeminently academic rather than practical tastes of the majority of its compilers. For example, no word is to be found as to the electrochemical equivalents of the metals, or as to the flash and firing points of the various oils used in industry. A mixture such as petrol has properties as definite as many single substances, and is vastly more important than many out-of-the-way bodies the properties of which are here detailed. The work is a monument to the industry and book-learning of the German professor, but if it had to be translated into English many changes might be introduced with advantage. One can picture the trained electro-chemist of an up-to-date American works expressing his disappointment when he finds that, though he could revel in pages of "Ueberführungszahlen," yet important bodies like carborundum and siloxicon are not even mentioned, and he would appeal in vain to the book if he wished to ascertain whether magnesia or alumina had the lower melting point.

The following may serve as an example of the somewhat irritating way in which some of the data are expressed. We conventionally divide all substances into electrical insulators and conductors, and again we divide the metals and alloys into those used for *current-carrying* and those employed as *resistances*. It may be *academically* correct to lump all these together and tabulate their conductivity as a number multiplied by a factor varying from  $10^4$  to  $10^{-18}$ , but there is no question as to the superior *utility* of giving the resistivity of the usual insulators in megohms or millions of megohms per centimetre cube and that of the other materials both in microhms and in terms of copper.

We are glad to notice that in the matter of units many improvements have been made on the old edition. The three confusing brands of calories met with in thermochemistry have been unified, and in the section on thermal conductivity the C.G.S. system has displaced the inconvenient units formerly employed.

The information given in the book is on the whole accurately compiled,<sup>1</sup> yet we regret to find that misprints, which have been corrected by their authors,

<sup>1</sup> A list of a few errors discovered has been sent to the authors.

should be repeated in a work of this kind. For example, Violle's value for the melting point of gold is given as it was printed in his original paper in 1879—namely,  $1035^{\circ}$  C. Two years later (*C.R.*, xcii. p. 866) he stated that this was a printer's error for  $1045^{\circ}$  C. Still later he admitted that the value  $1045^{\circ}$  needed raising  $15^{\circ}$  or  $20^{\circ}$ , thus bringing his figure into complete accord with the results of modern observers. Yet no mention of these facts is made in the book, nor is any account taken of the influence of this raising of the melting point of gold on the results obtained for numerous other substances, using pyrometers standardised by this melting point.

Again, several papers by American physicists have been written on the correction of Rowland's classic experiments on the mechanical equivalent of heat to bring his temperature-scale into agreement with modern standards; yet we find the values of Rowland's original paper given on p. 810 without comment.

In the table of dielectric constants the duration of the charge should have been specified, and the same applies to the table giving the resistance of insulators, where both the testing voltage and time of electrification are vital in determining the value obtained. In spite of many omissions, the book is the most complete and best of its kind, is well bound and printed, and should be found in every well-equipped laboratory of physics or chemistry.

J. A. HARKER.

#### THE PRINCIPLES OF SCIENCE.

*Erkenntnis und Irrtum.* By Prof. Ernst Mach. Pp. 461. (Leipzig: J. A. Barth, 1905.) Price 10 marks.

PROF. MACH is best known to English readers by the translation of his "Die Mechanik in ihrer Entwicklung." Those who have read that admirable book and know its interest will probably hasten to learn more of that philosophy of science which is only dimly indicated therein in a few casual but suggestive remarks. Perhaps they will be disappointed.

For Prof. Mach is no philosopher; he is a "Naturforscher"; he assures us of it at every opportunity; the mere name of philosophy fills him with horror. But unfortunately a hatred of other metaphysicians is not unknown among those included under the same name; it is just as metaphysical to condemn metaphysics as it is superstitious to belong to the "13 Club." A new answer to the problems of metaphysics does not exclude us from the circle of students of that subject, for only by ignoring those questions can we place ourselves outside it; whoever deals with such problems must be treated as a philosopher.

Prof. Mach's views on the philosophy of science are very similar to those which Prof. Pearson expresses in his "Grammar of Science"; his attitude approaches more nearly to sensationalism than to any other recognised system. Our sense impressions are for each of us the only ultimate facts and the only source whence knowledge can be derived. Science consists in the adaptation of our thoughts to one another, a process in which an

essential part is played by the conceptions which we form by generalising our perceptions. Knowledge, therefore, is attained in the simplification of our conceptions and in their harmony with our perceptions. No knowledge exists which is not scientific; we can deal with nothing but phenomena; "things in themselves" are meaningless, they are "monströse, unerkennbare." Causality is a conception derived from the constancy of association of some of our perceptions, and is nothing but a functional relation between phenomena. Geometry and other branches of pure mathematics consist of the study of the conceptions of space, time, number, and so on, to which we have been led by a study of phenomena and a consequent idealisation of our perceptions; the possibility of intuitive knowledge must be absolutely rejected. Such are the chief propositions which the author is concerned to establish.

It is clear that these propositions were designed to meet the needs of a student of natural science, and that only those assumptions have been made which are considered necessary and sufficient to prove them. Of course, this would be perfectly legitimate; it is not only logical, but in many ways advantageous, to decide definitely what assumptions must be made in order that science may be possible, to make those assumptions and to leave to others the discussion of their validity and their source. But our author has been in such a hurry to get within the fortress of science and to shut out the hostile metaphysician that he has left some of his necessary baggage outside; his assumptions are not sufficient for his purpose. Knowledge, he says, consists in the perfect harmony of our conceptions and perceptions; that is simply a matter of definition; but then he tells us that this knowledge can give us an expectation (*Erwartung*). Now our conceptions are derived from past perceptions, and if they are to give us any information about future perceptions it must be on the grounds that future sequences are likely to resemble past sequences. But this is a new proposition; we cannot prove it from "Naturforschung," for Prof. Mach admits that the only method which is available for the attainment of new knowledge by such a process is "incomplete induction," which involves the truth of this very proposition. We must either assume it or deduce it from some other source; for instance, we might deduce it from the uniformity of the observing self and plunge into Solipsism, or from the uniformity of some external agent and be forced to dispute with the metaphysician the questions of reality and existence.

The most satisfactory portion of the book is that in which the methods by which science has been advanced are analysed in detail and illustrated by some apt examples. The chapter on hypotheses directs attention to a sadly neglected principle. The cause of the fruitlessness of Baconian induction in the hands of its author and his followers lay in their neglect of hypotheses. Random experiments, however numerous, are always in vain; except by chance, no researches which have not been directed to the examination of some hypothetically suggested theorem have yielded any useful knowledge.